
Space Weather Technical Forecast

Issued on Tuesday, 29 March 2022 at 01:03 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales <https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales>

Space Weather Forecast Headline: Chance of further M-class flares throughout. Slight chance of further S1 or above radiation storms. G1-G2/Minor-Moderate geomagnetic storms likely on Day 3 (31 March).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Moderate, with an M4 flare at 28/1129UTC, originating from AR2975. This spot region has also subsequently produced several more M1 flares.

There are currently seven sunspot regions on the visible disc. AR2975 remains magnetically complex and continues to develop, with further growth in its intermediate spots, and the presence of two delta spots. AR2978 (Eho/Beta) continues to rotate from the SE limb and is showing minor trailer spot emergence. AR2976 in the northeast quadrant is currently the largest sunspot, with a very small, weak delta spot in its leading spot. AR2977 (NW quadrant) and AR2979 (SE quadrant), are now both classified Bxo/Beta, and have shown signs of decay. AR2974 (SW quadrant) remains a simple and stable uni-polar spot. Newly numbered AR2980 is currently a small bi-polar group in the northwest quadrant.

An Earth directed CME was associated with the M4 flare, but model results are still pending at present. However, an anticipated arrival is likely around the 31st (Day 3). A further halo CME followed an M1 flare (also from 2975) around 28/1920UTC, but has yet to be fully analysed. This is also expected to be at least partly Earth directed.

Solar Wind / Geomagnetic Activity: The solar wind, as observed by DSCOVR at L1, declined from peaks of around 560km/s to around 430km/s. The density has been mostly at average levels. The strength of the IMF, Bt, has been at weak at 2-6nT. The north-south component, Bz, weakly variable between +3 and -5 nT. The Phi angle was predominately positive (away from the Sun), but with brief transitions to negative. Geomagnetic activity was initially (Kp 4) before becoming Quiet (Kp 0-2) from 28/0600UTC.

Energetic Particles / Solar Radiation: The high energy proton flux (10MeV) measured at GOES-16 became enhanced soon after the M4 flare with an S1/Minor radiation storm, which peaked at 18pfu at 28/1450UTC, before dropping below the S1 threshold (10pfu) after 28/2115UTC.

The high energy (greater than 2 MeV) electron flux as observed by GOES-16 at GEO rose from background to Moderate levels, with a peak of 362pfu at 28/1150 and 2040 UTC, following recent coronal hole high speed stream influence. The observed fluence at 29/0000 UTC was 1.05e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is expected to be mostly Low, but with a chance of further M-class flares, and perhaps a slight chance of an isolated X-class flare. This risk mainly from region

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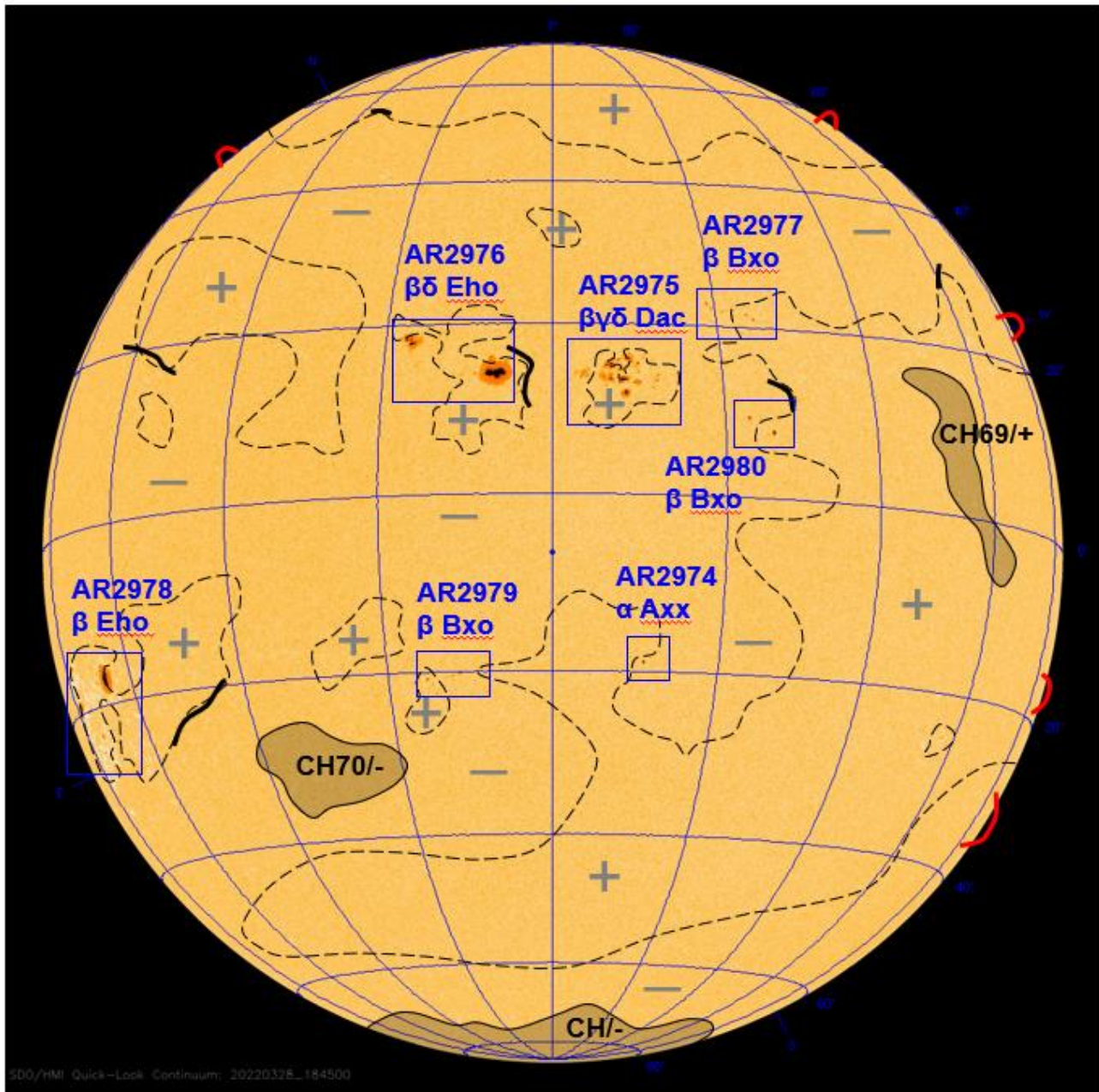
2975.

Solar Wind / Geomagnetic Activity: The next enhancement to the solar wind is expected to come from the 28th March CME arrival which is likely to be on Day 3 (31st March), although model results are still pending so this may be adjusted.

Quiet to Unsettled conditions are expected until Day 3 (31st Mar), when Active to G1-G2/Minor-Moderate storm periods are likely. Disturbed geomagnetic conditions are expected to continue into Day 4 (1st April).

Energetic Particles / Solar Radiation: The continued activity of 2975 in particular gives the slight chance of further potential enhancements above the S1 threshold during the period, particularly on Day 1 (29th) as proton flux levels are still recovering from the S1 event. A rising trend in electron flux values is possible through the coming days, perhaps reaching High levels at the diurnal peaks on Days 1 and 2 (29th and 30th March). From Day 3 (31st March) confidence becomes low, as the 28th March CME is likely to reach Earth (although model results are still pending), and this is likely to temporarily reduce flux levels. The associated 24 hour fluence is likely to follow a rising trend for the next 2 days, but remain below the Active ($1e8$ integrated pfu) threshold. Again beyond this confidence becomes low, as fluence levels are likely to become erratic due to CME influence. REFM is considered to be giving reasonable guidance in the short term, showing a rising trend but remaining below Active levels.

Figure 1. Solar Analysis Valid 28/1900UTC.



Key: Filament ____, Prominence ____, Magnetic Field Line - - -, Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α - β - $\beta\gamma$ - $\beta\gamma\delta$ and Zurich-McIntosh Axx etc.

Geomagnetic Storms:

Solar wind speeds have declined from peaks of around 560km/s to around 430km/s at present, due to waning coronal hole influence. The next enhancement is expected to come from the 28th March CME arrival which is likely to be on Day 3 (31st March), although model results are still pending so this may be adjusted.

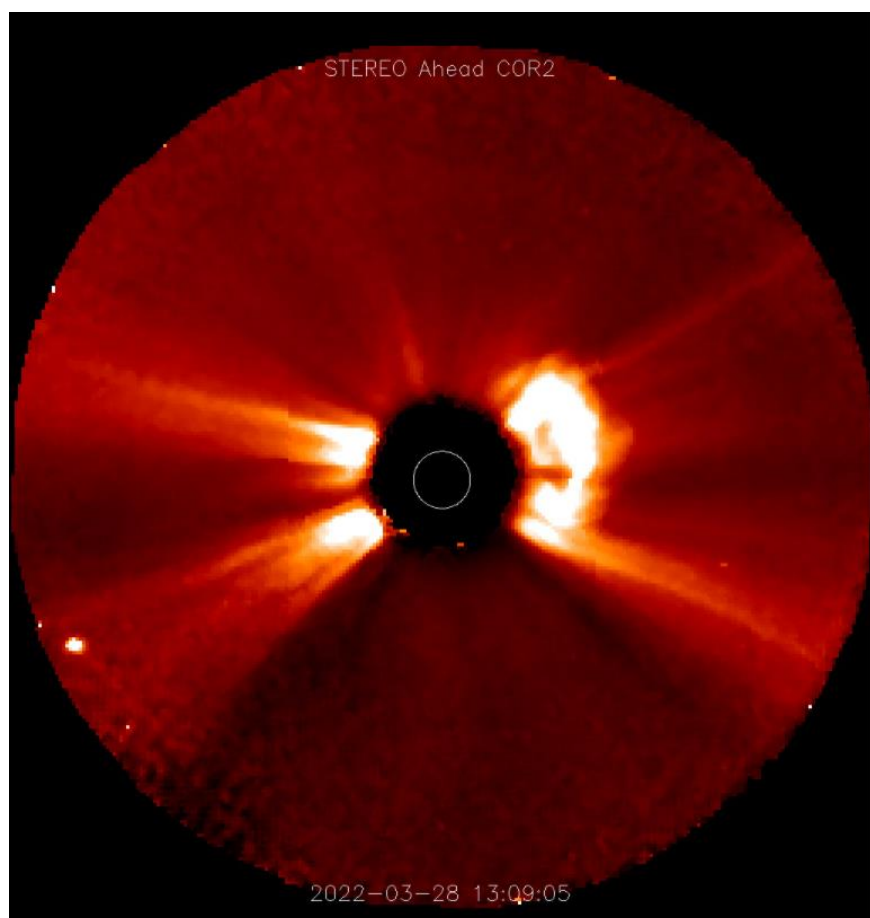
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Geo-Magnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	No	1	1	60	30
Strong	G3	No	1	1	5	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
28/1624 UTC	Halo	M4 flare 28/1129 UTC	AR2975	550	31 st March	Model results still pending at present. G1-G2 likely.

Figure 2: STEREO-Ahead image of emerging CME following the M4 flare.



Radio Blackouts - X-Ray Flares:

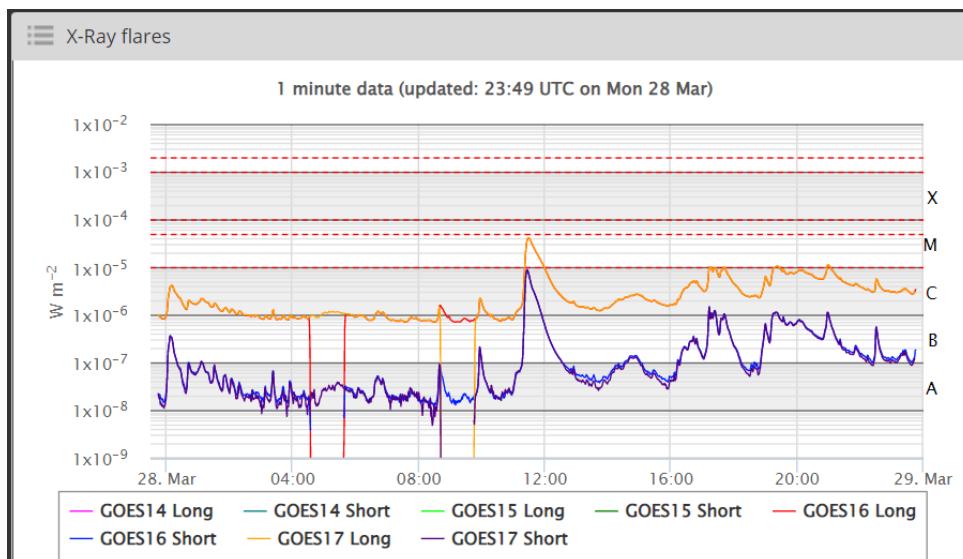
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Solar activity is expected to be mostly Low, but with a chance of further M-class flares, and perhaps a slight chance of an isolated X-class flare. This risk mainly from region 2975.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	50	50	50	50
Very Active	R3 to R5 X Class	No	10	10	10	10

Figure 3: X-ray flux from GOES16 and 17 satellites.



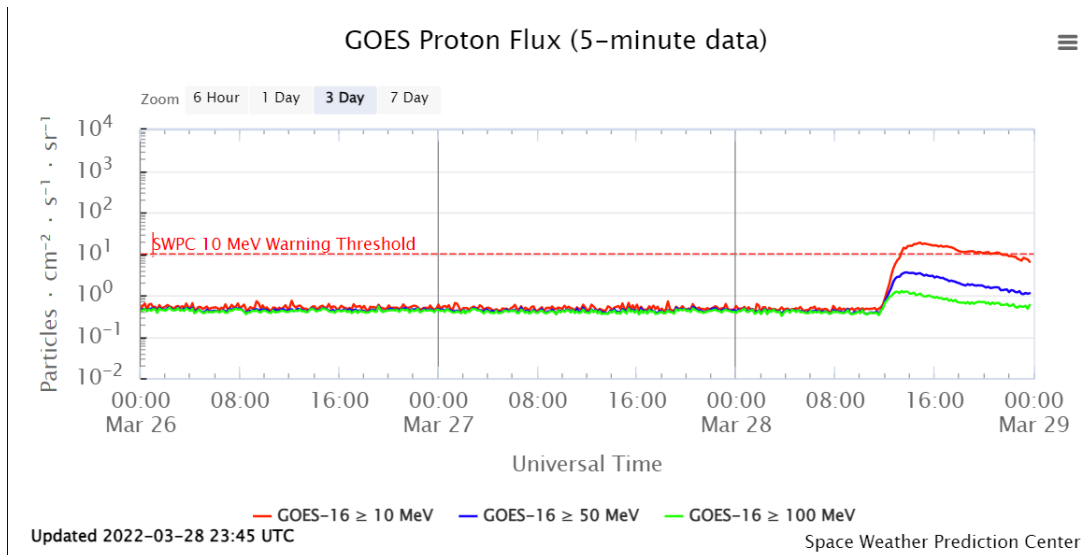
Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (10MeV) measured at GOES-16 became enhanced soon after the M4 flare with an S1/Minor radiation storm, which peaked at 18pfu at 28/1450UTC, before dropping below the S1 threshold (10pfu) after 28/2115UTC. The continued activity of 2975 in particular gives the slight chance of further potential enhancements above the S1 threshold during the period, particularly on Day 1 (29th) as proton flux levels are still recovering from the S1 event.

Radiation Storms	Level ($\text{cm}^{-2} \text{sr}^{-1} \text{s}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq \text{S1}$	Yes	20	10	10	10
Very Active	$\geq \text{S3}$ *	No	1	1	1	1

* S3 $\geq 10 \text{ MeV} \geq 1000 \text{ pfu}$ and / or $\geq 50 \text{ MeV} \geq 10 \text{ pfu}$. (pfu = $\text{cm}^{-2}\text{sr}^{-1}\text{s}^{-1}$)

Figure 4: GOES16 Proton flux (image courtesy of NOAA/SWPC)



High Energy Electrons Event ($\geq 2\text{MeV}$):

The high energy (greater than 2 MeV) electron flux, as observed by GOES-16 at GEO, rose from background to Moderate levels, with a peak of 362pfu at 28/1150 and 2040 UTC, following recent coronal hole high speed stream influence. A rising trend in electron flux values is possible through the coming days, perhaps reaching High levels at the diurnal peaks on Days 1 and 2 (29th and 30th March). From Day 3 (31st March) confidence becomes low, as the 28th March CME is likely to reach Earth (although model results are still pending), and this is likely to temporarily reduce flux levels.

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GEO Electron Environment	Level ($\text{cm}^{-2} \text{sr}^{-1} \text{day}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^8$	No	10	20	20	30
Very Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^9$	No	1	1	1	5

Figure 5: MOSWOC REFM output.

